



THE ANNALS OF THORACIC SURGERY



Mechanical Occlusion of the Inferior Vena Cava: An Unusual Complication After Repair of Pectus Excavatum Using the Nuss Procedure

Dilip S. Nath, Winfield J. Wells and Brian L. Reemtsen

Ann Thorac Surg 2008;85:1796-1798

DOI: 10.1016/j.athoracsur.2007.10.045

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://ats.ctsnetjournals.org/cgi/content/full/85/5/1796>

The Annals of Thoracic Surgery is the official journal of The Society of Thoracic Surgeons and the Southern Thoracic Surgical Association. Copyright © 2008 by The Society of Thoracic Surgeons. Print ISSN: 0003-4975; eISSN: 1552-6259.

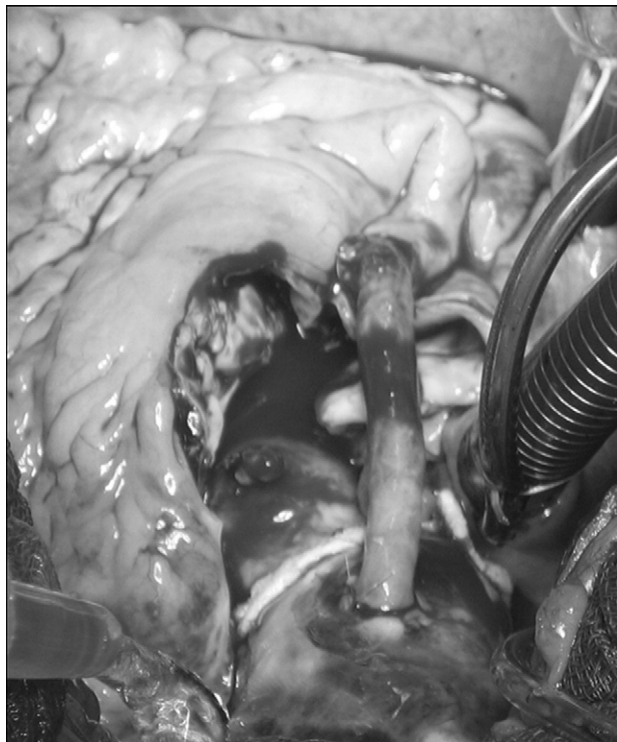


Fig 2. Intraoperative photograph demonstrating resection and bypass of 6-cm right coronary artery aneurysm.

This case is a young female patient found to have giant coronary artery aneurysms. In reviewing the literature, it seems to be the first case of Takayasu's arteritis related to coronary artery aneurysm treated surgically with a good result.

We chose to use saphenous vein grafts in our young patient. We were concerned that future involvement of the subclavian artery in Takayasu's arteritis would jeopardize an internal mammary artery graft if used. In their discussion, Endo and colleagues [3] supported the idea that use of the internal mammary artery for bypass surgery in Takayasu's arteritis patients is not recommended.

Finally, in coronary bypass for patients with Takayasu's arteritis, graft occlusion occurs mainly at the proximal anastomotic site secondary to aortic intimal thickening [3]. In our young patient, this certainly will be a future point of concern that will need close follow-up in her postoperative care.

References

1. Suzuki H, Daida H, Tanaka M, et al. Giant aneurysm of the left main coronary artery in Takayasu aortitis. *Heart* 1999;81:214-7.
2. Khalaf HH, Arafah MR, Refaat AA, Ibrahim MF. Coronary artery bypass grafting for Takayasu arteritis with severe coronary, carotid, subclavian, and renal artery involvement and subsequent pregnancy. *Interact Cardiovasc Thorac Surg* 2006;5:153-5.
3. Endo M, Tomizawa Y, Nishida H, et al. Angiographic findings and surgical treatments of coronary artery involvement in Takayasu arteritis. *J Thorac Cardiovasc Surg* 2003;125:570-7.

4. Matsubara O, Kuwata T, Nemoto T, Kasuga T, Numano F. Coronary artery lesions in Takayasu arteritis: pathological considerations. *Heart Vessels* 1992;7:26-31.
5. Ishikawa K, Maetani S. Long-term outcome for 120 Japanese patients with Takayasu's disease. *Circulation* 1994;90:1855-60.

Mechanical Occlusion of the Inferior Vena Cava: An Unusual Complication After Repair of Pectus Excavatum Using the Nuss Procedure

Dilip S. Nath, MD, Winfield J. Wells, MD, and Brian L. Reemtsen, MD

Children's Hospital Los Angeles, Division of Cardiothoracic Surgery, Los Angeles, California

We describe the case of a 13-year-old girl with a pectus excavatum in whom acute occlusion of the inferior vena cava developed after a nuss repair. In this hemodynamically unstable patient, we evaluated the possibility of a penetrating injury to the thoracic and abdominal structures before confirming the diagnosis of inferior vena cava obstruction with a venogram. Removal of the nuss bar relieved the unexpected problem.

(Ann Thorac Surg 2008;85:1796-8)

© 2008 by The Society of Thoracic Surgeons

The Nuss procedure has been widely used to correct pectum excavatum. Although uncommon, major complications including penetrating injury to mediastinal and abdominal structures have been reported [1]. We describe a patient in whom acute hemodynamic instability developed after a seemingly uncomplicated Nuss operation. We believe that the cause of this patient's problem has not been previously described.

A 13-year-old girl with moderate to severe symmetric pectus excavatum involving the lower gladiolus and xyphoid was taken for repair of her defect. After induction of general anesthesia and placement of a thoracic epidural, the operation was conducted in accordance with the technique described by Nuss and colleagues [2]. A thoracoscope in the right chest was used to guide the tunneling instrument. As the pre-formed Nuss bar was guided through the retrosternal tunnel in the seventh interspace, there was a breach of the pericardium heralded by the appearance of serous fluid. The final bar position yielded an excellent repair of the pectus deformity.

In the recovery room the patient became hypotensive. After discovery of a right pneumothorax, a chest tube was placed, but hypotension persisted. Epidural medications were discontinued; however, despite this and the initiation

Accepted for publication Oct 10, 2007.

Address correspondence to Dr Reemtsen, Children's Hospital Los Angeles, Division of Cardiothoracic Surgery, 4650 Sunset Blvd, MS 66, Los Angeles, CA 90027; e-mail: breemtsen@chla.usc.edu.

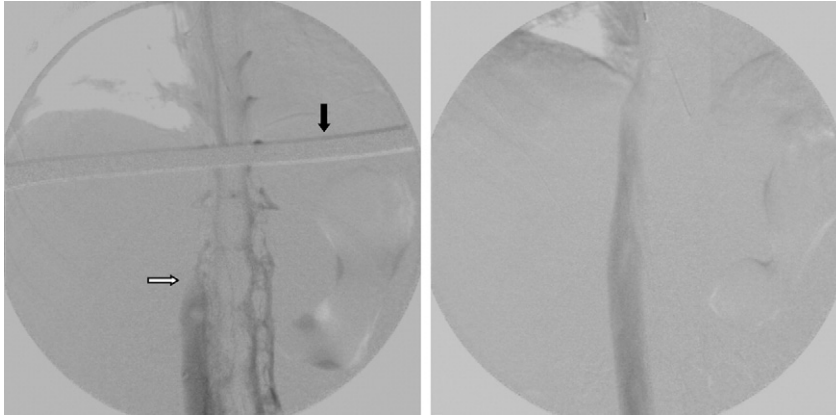


Fig 1. (Left) Venogram with Nuss bar (black arrow) demonstrates inferior vena cava occlusion (white arrow). (Right) Venogram with Nuss bar removed.

of aggressive fluid resuscitation and inotropic support, there continued to be poor perfusion and labile blood pressure. An echocardiogram showed no pericardial effusion, good cardiac function, and a relatively underfilled volume status. As these investigations were being carried out, follow-up examinations revealed progressive abdominal distension and a drop in hematocrit in excess of that expected from hemodilution. Exploratory laparotomy released a large volume of ascitic fluid under pressure. The liver was significantly congested, but the bowel was normal in color and consistency. After a laparotomy, the lower body appeared mottled with a line of demarcation at the costal margin. Femoral and subclavian venous catheters were introduced and the lower body venous pressure was 10 to 15 mm Hg higher than that in the upper body. A femoral venogram showed complete obstruction of the inferior cava at the diaphragm (Fig 1). Distortion related to the Nuss bar was suspected, and after bar removal there was immediate improvement in hemodynamics and perfusion. This was accompanied by equalization of upper and lower body venous pressures. Repeat venogram showed resolution of inferior vena cava (IVC) obstruction (Fig 1). Subsequent recovery was uneventful and the patient was discharged on postoperative day 5 after diuresis.

Comment

The Nuss procedure involves repair of pectus excavatum without resection of cartilage. An appropriately shaped metal bar is placed substernally. The bar elevates the posteriorly displaced sternum to obtain a suitable contour of the anterior chest wall. After a period of 2 years, the bar is removed and a permanent correction is achieved because the costal cartilages have remodeled along the reconstructed contour in the intervening years. Numerous studies have demonstrated enhancement of self-perception and quality of life [3]. Improved exercise tolerance secondary to changes in pulmonary and cardiac physiology has also been documented in some cases [4].

Since its introduction in 1987, the Nuss procedure has been modified to both improve the efficacy and safety of the operation [2]. These modifications include unilateral or bilateral thoracoscopy and a subxiphoid incision to assist in mediastinal dissection [5, 6]. Despite these changes, multi-

ple complications have been reported including infection (ie, superficial and mediastinitis), skeletal injury (ie, sternal fractures, sternoclavicular dislocations), allergic reaction and dislocation of the metallic bar, pulmonary complications (ie, pneumonia, pneumothorax, hemothorax), pericardial complications (ie, pericarditis, pericardial effusion), vascular complications (ie, pulmonary and aortic injury), penetrating injury to abdominal structures (ie, diaphragm, liver, spleen, and intestine), and neurologic complications (ie, thoracic outlet syndrome, Horner's syndrome, thoracic scoliosis) [1, 7]. The Nuss procedure has a negligible mortality and the overall morbidity is about 15%, with bar displacement and pneumothorax accounting for the vast majority of the complications [7].

We report, we believe for the first time, an acute obstruction of the IVC, despite the seemingly appropriate placement of a Nuss bar. The underlying mechanism of this complication is unclear. One possibility is that the bar compressed the liver such that the liver in turn was pushing down on the infrahepatic vena cava. Although the liver appeared congested at laparotomy, palpation over the dome of the liver did not detect impingement by the Nuss bar. Of note, the IVC obstruction can not be attributed to abdominal compartment syndrome because the venogram that diagnosed the problem was obtained after laparotomy and drainage of the large ascitic fluid collection.

An alternate and more compelling explanation is that the bar ensnared the right anterolateral pericardium causing axial traction with torsion of the IVC. Although this diagnosis was considered, the normal chest x-ray film and a nondiagnostic echocardiogram made this explanation seem unlikely. Interestingly, there is a report of a patient with a pectus excavatum who demonstrated compression of the IVC at the diaphragm during inspiration on preoperative imaging [8]. It is possible that the combination of the aforementioned traction and a very mobile mediastinum was the reason for the isolated IVC obstruction.

In regard to patient management, we believe that exploratory laparotomy was an appropriate step in addressing our patient's critical condition. In retrospect, the fluid noted on the abdominal ultrasound was ascitis related to aggressive crystalloid infusion during resuscitation in a patient with an acute IVC obstruction. However, a patient with hemodynamic instability after a Nuss procedure must be suspected

to have a penetrating injury to the thoracic and abdominal organs until proven otherwise.

The Nuss procedure, particularly with modifications such as thoracoscopic visualization, remains a safe and effective method for the repair of pectus excavatum. We report the complication of IVC obstruction after placement of a Nuss bar (and subsequent resolution with bar removal) as a cautionary note that even with seemingly well-controlled thoracic procedures the potential for an unusual and fatal injury remains present.

References

1. Leonhardt J, Kubler JF, Feiter J, et al. Complications of the minimally invasive repair of pectus excavatum. *J Pediatr Surg* 2005;40:e7–9.
2. Nuss D, Kelly RE, Croitoru DP, et al. A 10-year review of a minimally invasive technique for the correction of pectus excavatum. *J Pediatr Surg* 1998;33:545–52.
3. Roberts J, Hayashi A, Anderson JO, et al. Quality of life of patients who have undergone the Nuss procedure for pectus excavatum: preliminary findings. *J Pediatr Surg* 2003;38:779–83.
4. Sigalet DL, Montgomery M, Harder J, et al. Long term cardiopulmonary effects of closed repair of pectus excavatum. *Pediatr Surg Int* 2007;23:493–7.
5. Miller KA, Woods RK, Sharp RJ, et al. Minimally invasive repair of pectus excavatum: a single institution's experience. *Surgery* 2001;130:657–9.
6. Palmer B, Yedlin S, Kim S. Decreased risk of complications with bilateral thoracoscopy and left-to-right mediastinal dissection during minimally invasive repair of pectus excavatum. *Eur J Pediatr Surg* 2007;17:81–3.
7. Hebra A, Swoveland B, Egbert M, et al. Outcome analysis of minimally invasive repair of pectus excavatum: review of 251 cases. *J Pediatr Surg* 2000;35:252–8.
8. Yalamanchili K, Summer W, Valentine V. Pectus excavatum with inspiratory inferior vena cava compression: a new presentation of pulsus paradoxus. *Am J Med Sci* 2005;329:45–7.

Orthodeoxia-Platypnea Syndrome Presenting as Paradoxical Peripheral Embolism

Sophie Delalieux, MD, Kathleen De Greef, MD, PhD, Jeroen Hendriks, MD, PhD, Patrick Lauwers, MD, Bert Suys, MD, and Paul Van Schil, MD, PhD

Departments of Thoracic and Vascular Surgery and Pediatrics, University Hospital of Antwerp, Edegem, Antwerp, Belgium

A paradoxical embolus associated with orthodeoxia-platypnea syndrome and intracardiac shunting is extremely uncommon. We present a patient who was found to have a positional change in desaturation after a right pneumonectomy who suffered from gangrene of the right foot and simultaneous deep venous thrombosis of the left arm. Workup revealed a patent foramen ovale as a cause for both the right-to-left shunt and the paradoxical emboli. After percutaneous closure the orthodeoxia re-

solved. This case highlights the necessity of heightened awareness of this syndrome in case of severe hypoxemia after pneumonectomy and the importance of an occult patent foramen ovale.

(Ann Thorac Surg 2008;85:1798–800)

© 2008 by The Society of Thoracic Surgeons

Orthodeoxia-platypnea syndrome causes posture-dependent desaturation and may occur after pneumonectomy or can be associated with cirrhosis of the liver, recurrent pulmonary embolism, and intracardiac shunting. Right-to-left interatrial shunt due to an atrial septal defect or patent foramen ovale is the most common cause of this syndrome. A patient with a deep venous thrombosis can have a paradoxical embolism to the left side due to a patent foramen ovale. We present a patient who was found to have orthodeoxia-platypnea syndrome and paradoxical embolism at the same time after a right pneumonectomy.

A 51-year-old man was referred with a histologically proven well-differentiated spinocellular carcinoma of the right upper lobe. On computed tomography of the thorax, enlarged mediastinal lymph nodes were present. Because a positive lymph node at the tracheobronchial angle (station 4R, stage IIIA–N2) was discovered during cervical mediastinoscopy, the patient underwent induction chemoradiotherapy. Re-mediastinoscopy was negative and the patient underwent a right thoracotomy with subsequent intrapericardial pneumonectomy, which was necessary because of dense hilar adhesions. Pathology of the lung revealed no residual viable tumor and all dissected intrapulmonary, hilar, and mediastinal lymph nodes were negative. Immediately after surgery, the patient was extubated and he was hemodynamically stable. However, acute dyspnea and respiratory insufficiency developed 3 days later and the patient was reintubated. One week postoperatively, a deep venous thrombosis of the left brachial vein was diagnosed. A few days later he had a trash foot with necrotic toes develop (Figs 1, 2). At that time, a patent foramen ovale (PFO) was suspected and the diagnosis of a right-to-left interatrial shunt through a PFO was confirmed by transesophageal echocardiography with color Doppler. At postoperative day 38, a percutaneous closure of the right-to-left shunt was performed using a transcatheter device (Figs 3, 4). The patient was able to be weaned from the ventilator 2 days later and subsequently he underwent amputation of the necrotic toes. Wound healing was normal and he was able to be discharged from the hospital 2 months after the intrapericardial pneumonectomy. The patient subsequently died 10 months postoperatively from metastatic disease.

Comment

Orthodeoxia (ie, posture-dependent desaturation) with platypnea (ie, flat-breathing) is an uncommon syndrome that may occur after pneumonectomy or can be associ-

Accepted for publication Aug 6, 2007.

Address correspondence to Dr Van Schil, Department of Thoracic and Vascular Surgery, University Hospital of Antwerp, Wilrijkstraat 10, Edegem, Antwerp, B-2650, Belgium; e-mail: paul.van.schil@uza.be.

Mechanical Occlusion of the Inferior Vena Cava: An Unusual Complication After Repair of Pectus Excavatum Using the Nuss Procedure

Dilip S. Nath, Winfield J. Wells and Brian L. Reemtsen

Ann Thorac Surg 2008;85:1796-1798

DOI: 10.1016/j.athoracsur.2007.10.045

Updated Information & Services

including high-resolution figures, can be found at:
<http://ats.ctsnetjournals.org/cgi/content/full/85/5/1796>

Subspecialty Collections

This article, along with others on similar topics, appears in the following collection(s):

Chest wall

http://ats.ctsnetjournals.org/cgi/collection/chest_wall

Permissions & Licensing

Requests about reproducing this article in parts (figures, tables) or in its entirety should be submitted to:

<http://www.us.elsevierhealth.com/Licensing/permissions.jsp> or
email: healthpermissions@elsevier.com.

Reprints

For information about ordering reprints, please email:
reprints@elsevier.com



THE ANNALS OF THORACIC SURGERY

